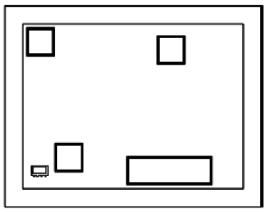
Ultra High Dynamic Range

Monolithic Amplifier Die

PHA-1-D+

50Ω 0.05 to 6 GHz



The Big Deal

- Ultra High IP3
- Broadband high dynamic range without external matching components

Product Overview

PHA-1-D+ is an advanced wideband amplifier die fabricated using E-pHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the PHA-1-D+ has good input and output return loss over a broad frequency range without the need for external matching components.

Key Features

Feature	Advantages
Broad Band: .05 to 6.0 GHz	Broadband covering primary wireless communications bands: Cellular, PCS, LTE, WiMAX
Extremely High IP3 versus DC power Consumption 38.8 dBm typical at 2 GHz	The PHA-1-D+ matches industry leading IP3 performance relative to power consumption. The combination of the design and E-pHEMT Structure provides enhanced linearity over a broad frequency range as evidence in the IP3 being typically 20 dB above the P1dB point. This feature makes this amplifier ideal for use in: • Driver amplifiers for complex waveform up converter paths • Drivers in linearized transmit systems • Secondary amplifiers in ultra High Dynamic range receivers
No External Matching Components Required	Mini-Circuits PHA-1-D+ provides good Input and Output Return Loss up to 4 GHz without the need for any external matching components
Low Noise Figure: 2.3dB typ. up to 3 GHz 3.6dB typ. up to 6 GHz	A unique feature of the PHA-1-D+ which separates this design from all competitors is the low noise figure performance in combination with the high dynamic range.

Low Noise, High IP3

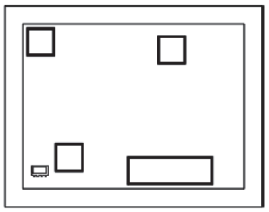
Monolithic Amplifier Die

PHA-1-D+

50Ω 0.05 to 6 GHz

Product Features

- High IP3, 38.8 dBm typ. at 2 GHz, 5V
- Gain, 13.6 dB typ. at 2 GHz, 5V
- High Pout, P1dB 22 dBm typ. at 2 GHz, 5V
- Low noise figure, 2.1 dB @2 GHz, 5V
- Usable to 4.0V
- No external matching components required



+RoHS Compliant

The +Suffix identifies RoHS Compliance. See our web site for RoHS Compliance methodologies and qualifications

Ordering Information: Refer to Last Page

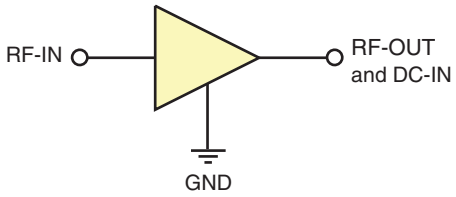
Typical Applications

- Base station infrastructure
- Portable Wireless
- CATV & DBS
- MMDS & Wireless LAN
- LTE

General Description

PHA-1-D+ (RoHS compliant) is an advanced wideband amplifier die MMIC fabricated using E-pHEMT technology and offers extremely high dynamic range over a broad frequency range and with low noise figure. In addition, the PHA-1-D+ has good input and output return loss over a broad frequency range without the need for external matching components.

Simplified Schematic and Pad description



Pad	Description
RF-IN	RF input pad. This pad requires the use of an external DC blocking capacitor chosen for the frequency of operation.
RF-OUT and DC-IN	RF output and bias pad. DC voltage is present on this pad; therefore a DC blocking capacitor is necessary for proper operation. An RF choke is needed to feed DC bias without loss of RF signal due to the bias connection.
GND	Connections to ground.

Note: 1. Bond Pad material - Gold
2. Bottom of Die - Gold plated

Electrical Specifications[1] at 25°C unless noted

Parameter	Condition (GHz)	Min.	Typ.	Max.	Units
Frequency Range		0.05		6	GHz
Gain	0.05		17.5		dB
	0.8		15.5		
	2.0		13.6		
	3.0		11.8		
	4.0		10.1		
	6.0		7.4		
Input Return Loss	0.05		11.3		dB
	0.8		16.9		
	2.0		12.5		
	3.0		9.3		
	4.0		8.3		
	6.0		6.5		
Output Return Loss	0.05		13.9		dB
	0.85		21.3		
	2.0		18.5		
	3.0		14.6		
	4.0		13.1		
	6.0		10.2		
Reverse Isolation	2.0		19.9		dB
Output Power at 1dB Compression	0.05		20.7		dBm
	0.8		22.6		
	2.0		22.5		
	3.0		21.8		
	4.0		21.9		
	6.0		20.9		
Output IP3	0.05		39.7		dBm
	0.8		38.5		
	2.0		38.5		
	3.0		38.4		
	4.0		38.6		
	6.0		36.9		
Noise Figure	0.05		1.7		dB
	0.8		1.9		
	2.0		2.1		
	3.0		2.3		
	4.0		2.7		
	6.0		3.6		
Supply Operating Voltage (V_{DD})		4.8	5.0	5.2	V
Device Operating Current at V_{DD}=5V		110	155	181	mA
Device Current Variation vs. Voltage			0.058		mA/V
Thermal Resistance, junction-to-ground lead			54		°C/W

1. Electrical Specifications are typical measured characteristics in Mini-Circuits die characterization test board. See Figure 1 for Test Circuit.

Absolute Maximum Ratings[2]

Parameter	Ratings
Operating Temperature (ground lead)	-40°C to 85°C
Operating Current at 5V	210 mA
Power Dissipation	1 W
Input Power (CW)	+24 dBm
DC Voltage at RF-OUT Pad [3]	6V

2. Permanent damage may occur if any of these limits are exceeded. These maximum ratings are not intended for continuous normal operations. Die performance measured in industry standard SOT-89 package.
3. For continuous operation, do not exceed 5.2V

Characterization Test Circuit

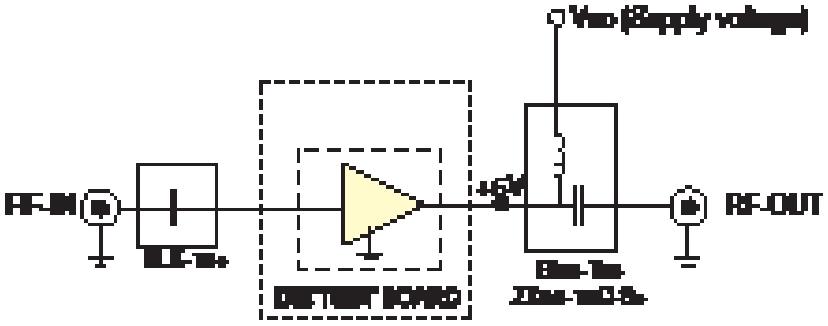


Figure 1: Block Diagram of Test Circuit used for characterization. Gain, Return loss, Output power at 1dB compression (P1 dB), output IP3 (OIP3) and noise figure measured using Agilent's N5242A PNA-X microwave network analyzer.

Conditions:
1. Gain and Return loss: Pad= -25dBm
2. Output IP3 (OIP3): Two tones, spaced 1 MHz apart, 5 dBm/tone at output.

Die Layout

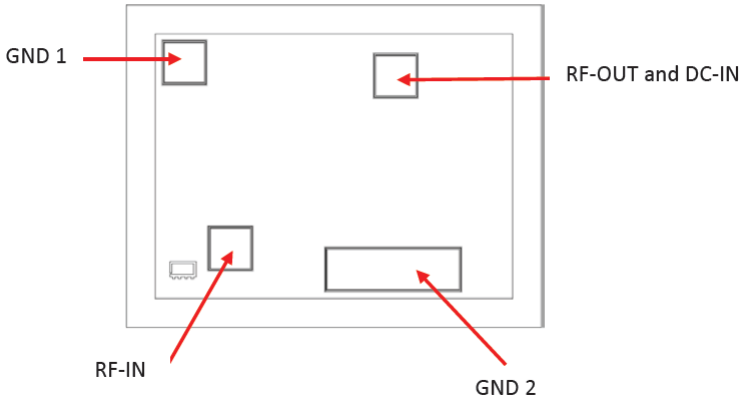


Fig 2. Die Layout

Bonding Pad Position

(Dimensions in µm, Typical)

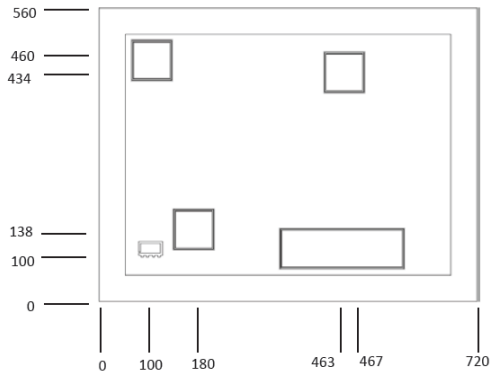


Fig 3. Bonding Pad Positions

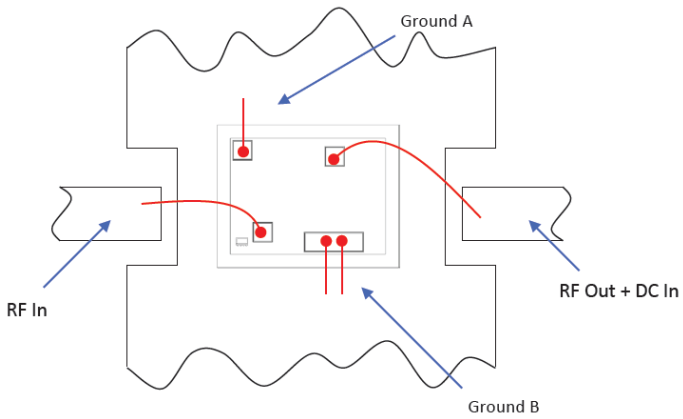
Critical Dimensions

Parameter	Values
Die Thickness, µm	100
Die Width, µm	560
Die Length, µm	720
Bond Pad Size, µm	80 x 80
Large Ground Bond Pad Size, µm	80 x 240

Assembly and Handling Procedure

1. Storage
   Dice should be stored in a dry nitrogen purged desiccators or equivalent.
2. ESD
   MMIC Gallium Arsenide (GaAs) amplifier dice are susceptible to electrostatic and mechanical damage. Die are supplied in antistatic protected material, which should be opened in clean room conditions at an appropriately grounded anti-static worksta tion. Devices need careful handling using correctly designed collets, vacuum pickup tips or sharp antistatic tweezers to deter ESD damage to dice.
3. Die Attach
   The die mounting surface must be clean and flat. Using conductive silver filled epoxy, recommended epoxies are DieMat DM6030HK-PT or Ablestik 84-1LMISR4. Apply sufficient epoxy to meet required epoxy bond line thickness, epoxy fillet height and epoxy coverage around total die periphery. Parts shall be cured in a nitrogen filled atmosphere per manufacturer's cure condition. It is recommended to use antistatic die pick up tools only.
4. Wire Bonding
   Bond pad openings in the surface passivation above the bond pads are provided to allow wire bonding to the dice gold bond pads. Thermosonic bonding is used with minimized ultrasonic content. Bond force, time, ultrasonic power and temperature are all critical parameters. Suggested wire is pure gold, 1 mil diameter. Bonds must be made from the bond pads on the die to the package or substrate. All bond wires should be kept as short as low as reasonable to minimize performance degradation due to undesirable series inductance.

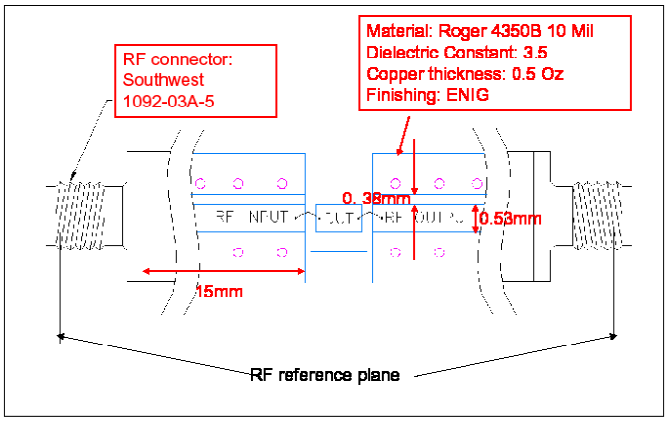
Assembly Diagram



Recommended Wire Length, Typical

Wire	Wire Length (mm)	Wire Loop Height (mm)
RF-IN, RF-OUT and DC-IN	0.70	0.15
GROUND A	0.30	0.15
GROUND B	0.60	0.15

RF Reference Plane - No port extension



Additional Detailed Technical Information

additional information is available on our dash board.

Performance Data	Data Table	
	Swept Graphs	
	S-Parameter (S2P Files) Data Set with and without port extension(.zip file)	
Case Style	Die	
Die Ordering and packaging information	Quantity, Package	Model No.
	Small, Gel - Pak: 5,10,50,100 KGD*	PHA-1-DG+
	Medium†, Partial wafer: KGD*<2435	PHA-1-DP+
	Large†, Full Wafer	PHA-1-DF+
	†*Available upon request contact sales representative*	
	Refer to AN-60-067	
Environmental Ratings	ENV-80	

*Known Good Dice ("KGD") means that the dice in question have been subjected to Mini-Circuits DC test performance criteria and measurement instructions and that the parametric data of such dice fall within a predefined range. While DC testing is not definitive, it does help to provide a higher degree of confidence that dice are capable of meeting typical RF electrical parameters specified by Mini-Circuits.

ESD Rating**

Human Body Model (HBM): Class 1A (250 to <500V) in accordance with ANSI/ESD STM 5.1 - 2001

** Tested in industry standard SOT-89 package.

Additional Notes

A. Performance and quality attributes and conditions not expressly stated in this specification document are intended to be excluded and do not form a part of this specification document.

B. Electrical specifications and performance data contained in this specification document are based on Mini-Circuit's applicable established test performance criteria and measurement instructions.

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Typical Performance Data

Full 2-Port Extension

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5V, Id = 155mA @Temperature = +25°C

FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	17.51	21.21	11.53	14.61	0.98	0.66	39.80	20.86	1.72
200	16.36	20.73	19.91	21.36	1.11	0.65	38.30	22.47	1.81
400	16.13	20.66	20.03	22.01	1.12	0.66	37.34	22.61	1.99
600	15.95	20.59	18.65	22.31	1.12	0.67	38.83	22.58	2.01
800	15.76	20.48	17.56	22.22	1.12	0.69	38.85	22.66	1.87
1000	15.54	20.31	16.63	22.13	1.12	0.69	38.53	22.33	1.91
1200	15.29	20.16	15.72	21.79	1.12	0.71	39.57	22.42	1.91
1400	15.04	19.94	14.84	21.02	1.11	0.72	38.96	22.69	1.92
1600	14.77	19.73	14.20	20.45	1.11	0.73	39.78	22.66	1.98
1800	14.48	19.49	13.58	19.87	1.11	0.73	39.54	22.48	1.98
2000	14.19	19.23	13.01	18.95	1.10	0.74	40.89	22.59	2.07
2200	13.88	18.98	12.32	17.79	1.10	0.75	41.94	22.63	2.11
2400	13.58	18.70	11.53	16.62	1.08	0.75	42.02	22.53	2.10
2600	13.26	18.46	10.83	15.76	1.07	0.77	40.21	22.05	2.18
2800	12.93	18.24	10.29	14.98	1.07	0.78	42.19	22.24	2.34
3000	12.59	18.01	9.82	14.38	1.06	0.79	39.35	22.00	2.26
3200	12.24	17.77	9.44	13.82	1.06	0.80	40.17	21.75	2.40
3400	11.91	17.55	9.16	13.42	1.05	0.81	41.76	22.05	2.48
3600	11.59	17.31	8.97	13.05	1.05	0.82	42.57	22.23	2.47
3800	11.30	17.05	8.87	12.69	1.04	0.82	41.75	22.10	2.58
4000	11.02	16.80	8.87	12.48	1.04	0.82	42.51	22.03	2.70
4200	10.75	16.54	8.91	12.32	1.04	0.82	42.25	22.14	2.67
4400	10.50	16.26	8.90	12.13	1.03	0.81	42.30	21.87	2.74
4600	10.26	15.99	8.85	11.97	1.03	0.81	42.08	22.01	2.80
4800	10.01	15.72	8.74	11.79	1.02	0.81	40.91	21.66	2.95
5000	9.77	15.46	8.54	11.57	1.02	0.80	41.33	22.09	2.98
5200	9.52	15.23	8.26	11.31	1.01	0.80	41.05	21.80	3.07
5400	9.26	15.02	7.89	10.89	1.01	0.80	41.76	21.95	3.26
5600	8.97	14.84	7.40	10.46	1.00	0.80	40.21	21.70	3.33
5800	8.65	14.68	6.89	9.97	0.99	0.81	39.37	21.29	3.39
6000	8.31	14.57	6.39	9.44	0.99	0.81	39.75	21.04	3.59
6200	7.95	14.48	5.95	8.96	0.98	0.82	39.39	20.99	3.73
6400	7.60	14.39	5.58	8.45	0.97	0.83	38.89	20.89	3.94
6600	7.26	14.29	5.28	8.10	0.96	0.84	39.15	21.10	4.03
6800	6.94	14.18	5.09	7.80	0.95	0.84	38.77	20.96	4.07
7000	6.64	14.06	4.99	7.61	0.94	0.85	38.69	21.03	4.22
7200	6.39	13.90	4.97	7.49	0.93	0.86	38.12	21.25	4.34
7400	6.19	13.70	4.99	7.42	0.91	0.87	38.32	21.33	4.40
7600	6.01	13.46	5.12	7.41	0.90	0.87	37.73	20.95	4.49
7800	5.87	13.21	5.31	7.44	0.90	0.87	38.11	21.25	4.56
8000	5.74	12.94	5.52	7.53	0.89	0.87	37.81	21.45	4.65

Typical Performance Data

Full 2-Port Extension

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 4.75V, Id = 141mA @Temperature = +25°C

FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	17.55	21.50	11.39	14.02	0.98	0.68	40.48	20.19	1.72
200	16.29	20.72	19.02	21.73	1.11	0.66	38.98	21.98	1.82
400	16.07	20.63	19.69	23.43	1.12	0.66	39.09	22.11	1.99
600	15.93	20.52	18.68	22.96	1.12	0.67	38.75	22.11	2.02
800	15.73	20.38	17.87	22.25	1.12	0.68	39.25	22.21	1.90
1000	15.51	20.22	17.06	21.75	1.12	0.69	38.76	21.88	1.89
1200	15.28	20.03	16.07	21.07	1.11	0.70	39.38	21.95	1.90
1400	15.02	19.82	15.23	20.43	1.11	0.71	39.06	22.22	1.95
1600	14.75	19.59	14.50	19.39	1.10	0.71	38.40	22.19	1.98
1800	14.47	19.33	13.77	18.49	1.10	0.72	39.02	22.00	1.98
2000	14.18	19.09	13.00	17.87	1.09	0.73	38.56	22.12	2.05
2200	13.88	18.83	12.20	17.43	1.08	0.74	40.16	22.18	2.12
2400	13.57	18.57	11.53	16.75	1.08	0.75	37.95	22.10	2.08
2600	13.23	18.31	10.92	15.72	1.07	0.75	39.09	21.65	2.20
2800	12.90	18.09	10.33	14.82	1.06	0.76	37.00	21.84	2.33
3000	12.56	17.85	9.81	14.08	1.05	0.77	39.59	21.59	2.28
3200	12.23	17.61	9.42	13.33	1.04	0.78	38.14	21.33	2.43
3400	11.91	17.37	9.10	12.90	1.04	0.79	39.39	21.60	2.48
3600	11.60	17.12	8.83	12.47	1.03	0.80	37.69	21.76	2.52
3800	11.30	16.88	8.61	12.18	1.02	0.81	38.25	21.63	2.53
4000	11.02	16.61	8.49	12.02	1.01	0.81	38.28	21.56	2.65
4200	10.76	16.34	8.48	11.89	1.00	0.81	38.13	21.68	2.65
4400	10.49	16.09	8.50	11.88	1.01	0.81	37.59	21.36	2.74
4600	10.24	15.83	8.51	11.69	1.01	0.81	37.47	21.52	2.79
4800	10.00	15.57	8.44	11.46	1.00	0.80	37.19	21.18	2.93
5000	9.75	15.33	8.29	11.25	1.00	0.80	38.43	21.59	2.97
5200	9.51	15.08	8.00	10.89	0.99	0.79	37.46	21.28	3.08
5400	9.24	14.87	7.61	10.62	0.99	0.79	38.32	21.41	3.22
5600	8.95	14.70	7.16	10.17	0.98	0.80	37.01	21.15	3.27
5800	8.65	14.53	6.70	9.59	0.97	0.79	36.64	20.74	3.40
6000	8.31	14.41	6.27	9.13	0.96	0.80	36.05	20.71	3.54
6200	7.96	14.32	5.89	8.71	0.96	0.81	35.82	20.48	3.69
6400	7.62	14.22	5.55	8.19	0.95	0.81	35.93	20.61	3.92
6600	7.28	14.13	5.28	7.85	0.94	0.82	35.84	20.66	3.97
6800	6.96	14.04	5.07	7.58	0.93	0.82	36.11	20.54	4.04
7000	6.66	13.91	4.94	7.34	0.92	0.83	35.52	20.60	4.16
7200	6.39	13.76	4.91	7.28	0.91	0.84	35.29	20.80	4.32
7400	6.17	13.57	4.98	7.23	0.91	0.85	35.07	20.85	4.35
7600	5.97	13.39	5.12	7.26	0.90	0.86	34.97	20.41	4.44
7800	5.81	13.13	5.31	7.36	0.90	0.86	35.27	20.64	4.45
8000	5.68	12.90	5.55	7.46	0.90	0.86	35.56	20.80	4.56

Typical Performance Data

Full 2-Port Extension

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5.25V, Id =170mA @Temperature = +25°C

FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	17.60	21.22	11.52	14.21	0.97	0.65	40.48	21.38	1.75
200	16.43	20.78	19.77	21.57	1.11	0.65	38.06	23.01	1.86
400	16.21	20.73	19.90	22.35	1.12	0.66	38.26	23.14	2.02
600	16.04	20.63	18.79	22.73	1.12	0.67	38.62	23.11	2.05
800	15.84	20.51	17.66	23.08	1.12	0.68	38.31	23.21	1.93
1000	15.63	20.37	16.74	22.35	1.12	0.69	38.64	22.88	1.94
1200	15.39	20.20	15.86	22.10	1.12	0.70	39.38	22.98	1.95
1400	15.13	19.98	15.10	21.46	1.11	0.71	39.34	23.26	1.98
1600	14.86	19.76	14.44	20.72	1.11	0.72	39.56	23.22	2.04
1800	14.58	19.53	13.76	20.18	1.11	0.73	40.34	23.03	2.05
2000	14.29	19.30	13.08	19.30	1.10	0.74	40.48	23.15	2.11
2200	13.98	19.04	12.37	18.08	1.10	0.74	40.97	23.20	2.17
2400	13.68	18.81	11.63	17.02	1.09	0.76	39.45	22.90	2.18
2600	13.36	18.56	11.01	16.18	1.08	0.76	41.01	22.40	2.24
2800	13.03	18.31	10.48	15.29	1.07	0.77	41.00	22.61	2.42
3000	12.69	18.06	9.99	14.64	1.06	0.78	41.72	22.36	2.31
3200	12.36	17.85	9.57	14.08	1.06	0.80	40.76	22.10	2.51
3400	12.03	17.62	9.27	13.63	1.05	0.81	42.20	22.63	2.56
3600	11.72	17.37	9.08	13.25	1.05	0.81	43.94	22.60	2.60
3800	11.43	17.10	8.97	12.89	1.04	0.81	42.79	22.68	2.70
4000	11.16	16.86	8.94	12.58	1.04	0.81	45.86	22.61	2.79
4200	10.89	16.57	8.95	12.37	1.03	0.81	46.16	22.72	2.76
4400	10.63	16.31	8.93	12.22	1.03	0.81	44.89	22.24	2.87
4600	10.40	16.04	8.91	12.11	1.02	0.81	46.56	22.39	2.93
4800	10.15	15.77	8.82	11.94	1.02	0.80	45.79	22.24	3.08
5000	9.91	15.50	8.60	11.69	1.01	0.80	46.91	22.69	3.13
5200	9.66	15.29	8.30	11.42	1.01	0.80	46.08	22.17	3.23
5400	9.40	15.05	7.93	11.03	1.00	0.80	44.73	22.55	3.37
5600	9.10	14.87	7.44	10.60	1.00	0.80	42.99	22.08	3.50
5800	8.79	14.72	6.93	10.09	0.99	0.80	43.99	21.87	3.59
6000	8.46	14.60	6.43	9.52	0.98	0.81	43.81	21.61	3.79
6200	8.10	14.49	5.98	9.01	0.97	0.82	41.87	21.57	3.90
6400	7.75	14.40	5.60	8.49	0.96	0.82	44.33	21.46	4.16
6600	7.40	14.31	5.30	8.12	0.95	0.83	42.40	21.49	4.21
6800	7.07	14.21	5.10	7.83	0.94	0.84	41.98	21.34	4.27
7000	6.77	14.07	4.99	7.64	0.93	0.85	40.87	21.41	4.47
7200	6.52	13.91	4.97	7.53	0.92	0.86	40.81	21.64	4.60
7400	6.30	13.71	5.00	7.47	0.91	0.87	41.03	21.93	4.64
7600	6.12	13.49	5.12	7.46	0.90	0.87	38.99	21.54	4.75
7800	5.98	13.22	5.29	7.47	0.88	0.87	40.53	21.84	4.76
8000	5.86	12.95	5.50	7.53	0.88	0.87	40.78	21.94	4.88

Typical Performance Data

Without Full 2-Port Extension

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 5V, Id = 155mA @Temperature = +25°C

FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	17.57	21.21	11.33	14.95	0.97	0.65	39.80	20.86	1.72
200	16.36	20.75	19.82	21.41	1.11	0.65	38.30	22.47	1.81
400	16.08	20.74	19.96	22.05	1.13	0.67	37.34	22.61	1.99
600	15.85	20.72	18.63	22.49	1.14	0.69	38.83	22.58	2.01
800	15.62	20.63	17.54	22.53	1.14	0.71	38.85	22.66	1.87
1000	15.36	20.49	16.63	22.49	1.14	0.72	38.53	22.33	1.91
1200	15.09	20.36	15.74	22.22	1.15	0.74	39.57	22.42	1.91
1400	14.81	20.17	14.87	21.51	1.15	0.75	38.96	22.69	1.92
1600	14.51	19.97	14.26	21.01	1.15	0.76	39.78	22.66	1.98
1800	14.19	19.78	13.67	20.40	1.15	0.77	39.54	22.48	1.98
2000	13.88	19.54	13.11	19.54	1.15	0.78	40.89	22.59	2.07
2200	13.55	19.30	12.44	18.34	1.15	0.79	41.94	22.63	2.11
2400	13.22	19.07	11.68	17.15	1.14	0.80	42.02	22.53	2.10
2600	12.88	18.86	10.98	16.32	1.13	0.81	40.21	22.05	2.18
2800	12.53	18.62	10.46	15.58	1.13	0.82	42.19	22.24	2.34
3000	12.17	18.41	9.99	15.03	1.13	0.84	39.35	22.00	2.26
3200	11.81	18.22	9.62	14.51	1.13	0.85	40.17	21.75	2.40
3400	11.46	17.99	9.36	14.14	1.13	0.86	41.76	22.05	2.48
3600	11.12	17.78	9.21	13.79	1.13	0.87	42.57	22.23	2.47
3800	10.82	17.56	9.12	13.44	1.13	0.87	41.75	22.10	2.58
4000	10.52	17.29	9.13	13.26	1.13	0.87	42.51	22.03	2.70
4200	10.23	17.06	9.18	13.10	1.13	0.87	42.25	22.14	2.67
4400	9.96	16.80	9.19	12.90	1.13	0.87	42.30	21.87	2.74
4600	9.71	16.55	9.14	12.75	1.13	0.87	42.08	22.01	2.80
4800	9.44	16.29	9.05	12.61	1.12	0.87	40.91	21.66	2.95
5000	9.18	16.06	8.87	12.40	1.12	0.87	41.33	22.09	2.98
5200	8.92	15.83	8.60	12.17	1.12	0.87	41.05	21.80	3.07
5400	8.65	15.63	8.25	11.77	1.11	0.87	41.76	21.95	3.26
5600	8.34	15.47	7.77	11.35	1.11	0.88	40.21	21.70	3.33
5800	8.01	15.33	7.27	10.85	1.11	0.88	39.37	21.29	3.39
6000	7.66	15.22	6.79	10.35	1.10	0.89	39.75	21.04	3.59
6200	7.28	15.14	6.36	9.89	1.10	0.90	39.39	20.99	3.73
6400	6.91	15.07	6.01	9.39	1.10	0.91	38.89	20.89	3.94
6600	6.55	15.00	5.73	9.06	1.09	0.92	39.15	21.10	4.03
6800	6.22	14.91	5.55	8.78	1.09	0.93	38.77	20.96	4.07
7000	5.92	14.80	5.46	8.60	1.09	0.94	38.69	21.03	4.22
7200	5.66	14.63	5.45	8.49	1.09	0.94	38.12	21.25	4.34
7400	5.44	14.44	5.49	8.42	1.08	0.95	38.32	21.33	4.40
7600	5.24	14.25	5.63	8.43	1.07	0.95	37.73	20.95	4.49
7800	5.09	13.99	5.82	8.47	1.07	0.95	38.11	21.25	4.56
8000	4.95	13.75	6.05	8.56	1.06	0.95	37.81	21.45	4.65

Typical Performance Data

Without Full 2-Port Extension

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

TEST CONDITIONS: Vd = 4.75V, Id = 141mA @Temperature = +25°C

FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	17.55	21.63	11.49	15.28	1.00	0.69	40.48	20.19	1.72
200	16.32	20.69	19.07	21.76	1.10	0.65	38.98	21.98	1.82
400	16.08	20.63	19.75	23.32	1.12	0.66	39.09	22.11	1.99
600	15.91	20.51	18.79	22.89	1.12	0.67	38.75	22.11	2.02
800	15.70	20.43	18.00	22.20	1.12	0.68	39.25	22.21	1.90
1000	15.46	20.27	17.24	21.68	1.12	0.69	38.76	21.88	1.89
1200	15.21	20.10	16.29	21.01	1.12	0.70	39.38	21.95	1.90
1400	14.94	19.91	15.46	20.40	1.12	0.72	39.06	22.22	1.95
1600	14.66	19.68	14.74	19.35	1.12	0.72	38.40	22.19	1.98
1800	14.36	19.45	14.03	18.48	1.11	0.73	39.02	22.00	1.98
2000	14.05	19.22	13.29	17.83	1.11	0.74	38.56	22.12	2.05
2200	13.73	18.97	12.51	17.40	1.11	0.75	40.16	22.18	2.12
2400	13.41	18.71	11.85	16.74	1.10	0.76	37.95	22.10	2.08
2600	13.06	18.50	11.26	15.72	1.10	0.77	39.09	21.65	2.20
2800	12.71	18.29	10.70	14.82	1.09	0.78	37.00	21.84	2.33
3000	12.36	18.05	10.19	14.10	1.09	0.79	39.59	21.59	2.28
3200	12.02	17.83	9.82	13.37	1.08	0.80	38.14	21.33	2.43
3400	11.69	17.60	9.52	12.94	1.08	0.81	39.39	21.60	2.48
3600	11.36	17.37	9.27	12.52	1.07	0.82	37.69	21.76	2.52
3800	11.05	17.14	9.07	12.24	1.06	0.83	38.25	21.63	2.53
4000	10.76	16.87	8.98	12.09	1.06	0.83	38.28	21.56	2.65
4200	10.48	16.62	8.97	11.96	1.06	0.83	38.13	21.68	2.65
4400	10.20	16.39	9.01	11.96	1.06	0.83	37.59	21.36	2.74
4600	9.94	16.13	9.03	11.79	1.06	0.83	37.47	21.52	2.79
4800	9.69	15.89	8.98	11.56	1.06	0.82	37.19	21.18	2.93
5000	9.42	15.66	8.84	11.35	1.06	0.82	38.43	21.59	2.97
5200	9.17	15.42	8.57	11.02	1.05	0.82	37.46	21.28	3.08
5400	8.89	15.23	8.20	10.76	1.05	0.82	38.32	21.41	3.22
5600	8.59	15.05	7.76	10.31	1.05	0.82	37.01	21.15	3.27
5800	8.27	14.91	7.31	9.74	1.04	0.82	36.64	20.74	3.40
6000	7.93	14.80	6.90	9.29	1.04	0.82	36.05	20.71	3.54
6200	7.56	14.73	6.53	8.87	1.04	0.83	35.82	20.48	3.69
6400	7.21	14.66	6.20	8.37	1.04	0.83	35.93	20.61	3.92
6600	6.85	14.56	5.94	8.05	1.03	0.84	35.84	20.66	3.97
6800	6.52	14.47	5.75	7.79	1.03	0.84	36.11	20.54	4.04
7000	6.21	14.37	5.63	7.56	1.02	0.85	35.52	20.60	4.16
7200	5.93	14.23	5.62	7.51	1.02	0.86	35.29	20.80	4.32
7400	5.70	14.06	5.71	7.47	1.02	0.87	35.07	20.85	4.35
7600	5.49	13.87	5.86	7.50	1.02	0.87	34.97	20.41	4.44
7800	5.32	13.64	6.05	7.62	1.01	0.88	35.27	20.64	4.45
8000	5.17	13.42	6.31	7.73	1.02	0.88	35.56	20.80	4.56

Typical Performance Data

Without Full 2-Port Extension

Definitions:

Input Return Loss = -S11 (dB)
Gain(Power Gain) = S21 (dB)
Reverse Isolation = -S12 (dB)
Output Return Loss = -S22 (dB)

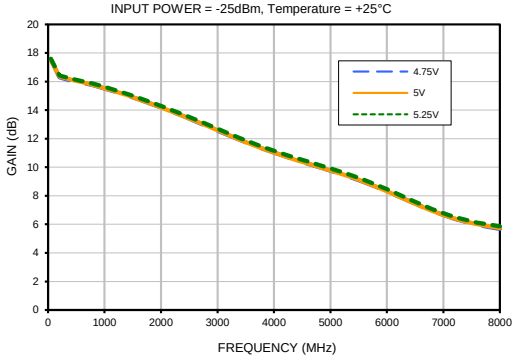
TEST CONDITIONS: Vd = 5.25V, Id =170mA @Temperature = +25°C

FREQ.	Gain	Isolation	Input Return Loss	Output Return Loss	Stability		IP-3 Output	1dB Comp. Output	Noise Figure
(MHz)	(dB)	(dB)	(dB)	(dB)	K	Measure	(dBm)	(dBm)	(dB)
50	17.60	21.58	11.55	14.58	0.99	0.67	40.48	21.38	1.75
200	16.41	20.82	19.71	21.54	1.11	0.65	38.06	23.01	1.86
400	16.10	20.87	19.95	22.12	1.13	0.68	38.26	23.14	2.02
600	15.84	20.85	18.97	22.60	1.15	0.70	38.62	23.11	2.05
800	15.56	20.83	17.55	23.67	1.16	0.72	38.31	23.21	1.93
1000	15.27	20.74	16.68	23.40	1.17	0.74	38.64	22.88	1.94
1200	14.96	20.64	15.93	23.26	1.18	0.76	39.38	22.98	1.95
1400	14.63	20.53	15.22	22.90	1.19	0.78	39.34	23.26	1.98
1600	14.29	20.36	14.59	22.68	1.20	0.79	39.56	23.22	2.04
1800	13.94	20.22	13.92	21.90	1.21	0.81	40.34	23.03	2.05
2000	13.59	20.04	13.28	20.58	1.22	0.82	40.48	23.15	2.11
2200	13.23	19.83	12.70	18.70	1.22	0.83	40.97	23.20	2.17
2400	12.87	19.62	12.02	17.67	1.22	0.84	39.45	22.90	2.18
2600	12.52	19.41	11.38	17.24	1.22	0.86	41.01	22.40	2.24
2800	12.15	19.20	10.78	16.61	1.22	0.87	41.00	22.61	2.42
3000	11.78	19.04	10.26	16.23	1.23	0.89	41.72	22.36	2.31
3200	11.42	18.81	9.83	15.70	1.22	0.90	40.76	22.10	2.51
3400	11.07	18.60	9.57	15.30	1.23	0.91	42.20	22.63	2.56
3600	10.74	18.36	9.45	15.01	1.23	0.91	43.94	22.60	2.60
3800	10.45	18.10	9.40	14.71	1.23	0.91	42.79	22.68	2.70
4000	10.17	17.86	9.39	14.40	1.23	0.91	45.86	22.61	2.79
4200	9.91	17.58	9.37	14.10	1.22	0.91	46.16	22.72	2.76
4400	9.64	17.31	9.36	13.92	1.22	0.91	44.89	22.24	2.87
4600	9.40	17.04	9.34	13.75	1.21	0.91	46.56	22.39	2.93
4800	9.15	16.79	9.24	13.50	1.21	0.91	45.79	22.24	3.08
5000	8.91	16.53	9.02	13.07	1.20	0.91	46.91	22.69	3.13
5200	8.66	16.28	8.74	12.83	1.19	0.91	46.08	22.17	3.23
5400	8.40	16.05	8.40	12.51	1.18	0.91	44.73	22.55	3.37
5600	8.10	15.87	7.92	12.04	1.18	0.91	42.99	22.08	3.50
5800	7.78	15.73	7.41	11.58	1.17	0.92	43.99	21.87	3.59
6000	7.44	15.61	6.95	11.05	1.17	0.93	43.81	21.61	3.79
6200	7.08	15.52	6.51	10.60	1.16	0.95	41.87	21.57	3.90
6400	6.72	15.44	6.13	10.05	1.16	0.95	44.33	21.46	4.16
6600	6.35	15.34	5.88	9.73	1.16	0.96	42.40	21.49	4.21
6800	6.03	15.23	5.70	9.37	1.16	0.97	41.98	21.34	4.27
7000	5.74	15.10	5.60	9.13	1.15	0.97	40.87	21.41	4.47
7200	5.49	14.93	5.58	9.02	1.15	0.98	40.81	21.64	4.60
7400	5.27	14.74	5.63	8.96	1.14	0.98	41.03	21.93	4.64
7600	5.09	14.51	5.73	8.86	1.13	0.98	38.99	21.54	4.75
7800	4.94	14.25	5.89	8.89	1.12	0.98	40.53	21.84	4.76
8000	4.80	14.02	6.09	8.92	1.11	0.97	40.78	21.94	4.88

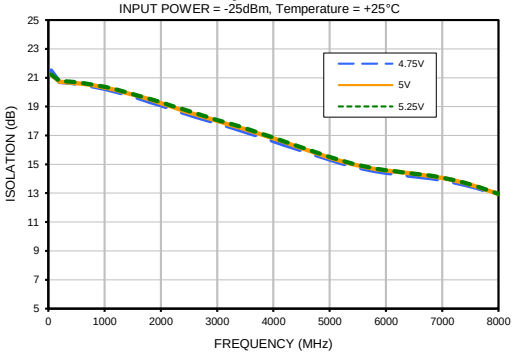
Typical Performance Curves

Full 2-Port Extension

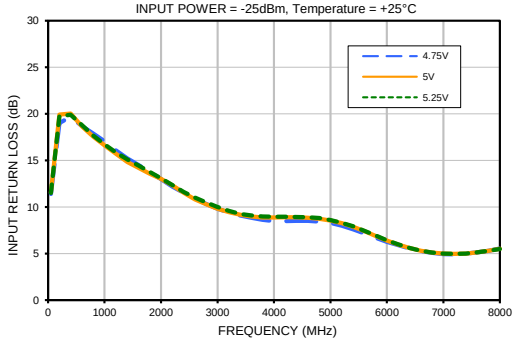
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



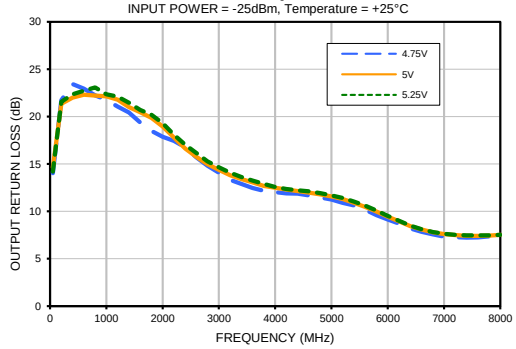
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



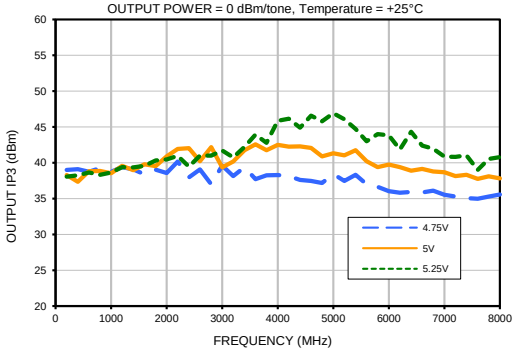
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



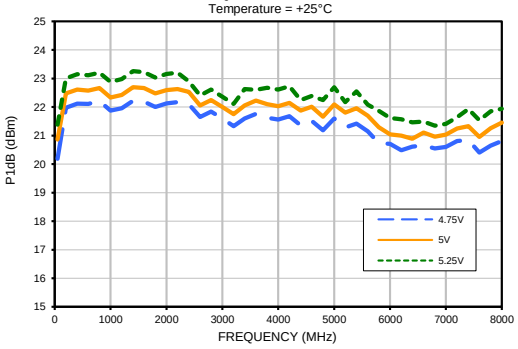
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



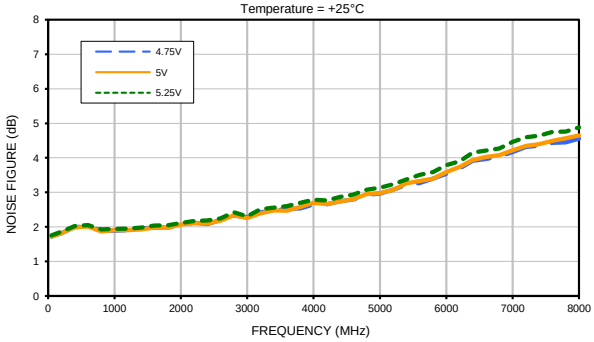
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
OUTPUT POWER = 0 dBm/tone, Temperature = +25°C



P1dB vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



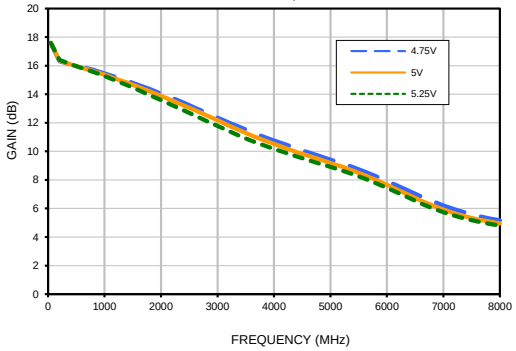
NOISE FIGURE vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



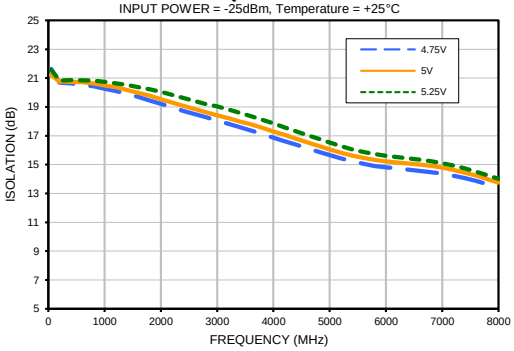
Typical Performance Curves

Without Full 2-Port Extension

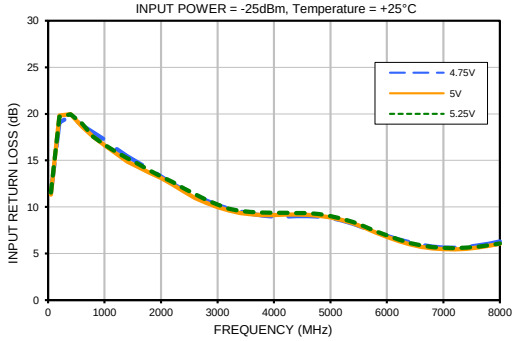
GAIN vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



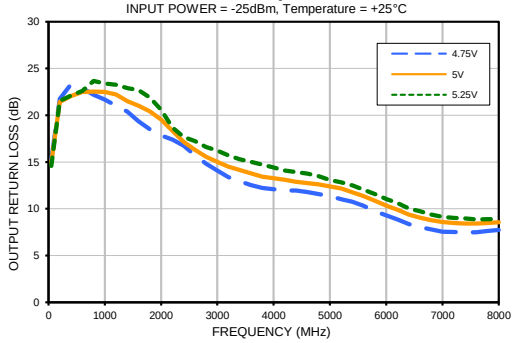
ISOLATION vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



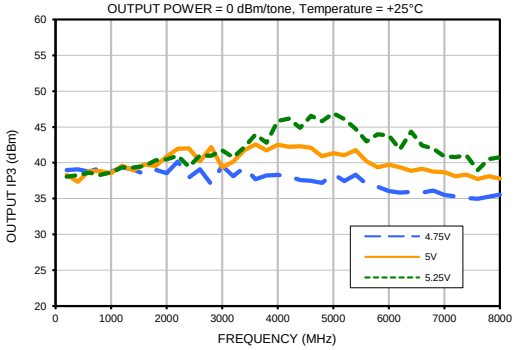
INPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



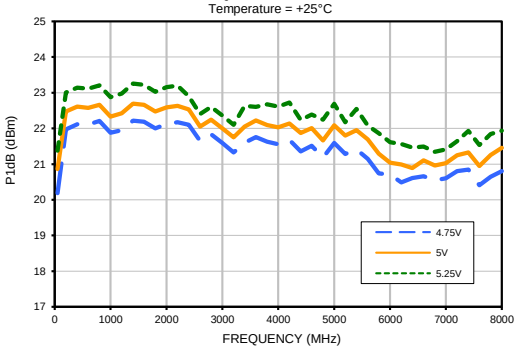
OUTPUT RETURN LOSS vs. FREQUENCY & DEVICE VOLTAGE
INPUT POWER = -25dBm, Temperature = +25°C



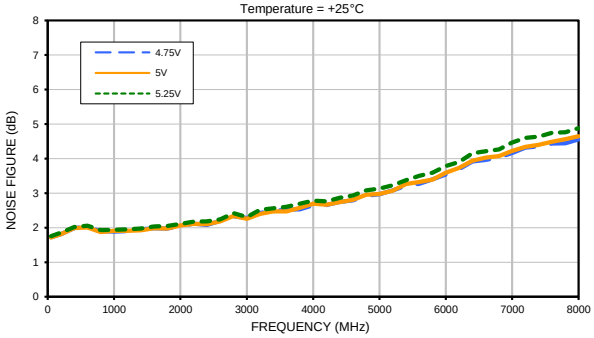
OUTPUT IP3 vs. FREQUENCY & DEVICE VOLTAGE
OUTPUT POWER = 0 dBm/tone, Temperature = +25°C



P1dB vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



NOISE FIGURE vs. FREQUENCY & DEVICE VOLTAGE
Temperature = +25°C



Mini-Circuits

Environmental Specifications ENV80

All Mini-Circuits products are manufactured under exacting quality assurance and control standards, and are capable of meeting published specifications after being subjected to any or all of the following physical and environmental test.

Specification	Test/Inspection Condition	Reference/Spec
Operating Temperature	-40° to 85° C or -40° to 105° C or -55° to 105° C or -45° to 105° C Ambient Environment	Refer to Individual Model Data Sheet
Storage Environment (Die)	-65° to 150°C	Individual Model Data Sheet
Storage Environment(Packaging)	-40° to 70°C and 40 to 60% humidity (In Factory Shipped Package)	